

1       What is claimed is:

2

3           1. An auxiliary power unit (APU) for a transport vehicle powered by an internal combustion  
4       engine, comprising:

5               an enclosure for housing and supporting the auxiliary power unit on the transport vehicle;  
6               an air-cooled engine having an output shaft and enclosed within the enclosure with and  
7       directly driving an air-cooled, brushless generator having an armature shaft, wherein the air-cooled  
8       engine utilizes fuel supply, exhaust and electrical systems of the transport vehicle engine and the  
9       generator provides direct, simultaneous AC and DC voltage outputs without requiring an inverter or  
10      a converter circuit; and

11               first and second air duct systems within the enclosure for separately conveying cooling air into  
12       and through the air-cooled engine and the generator respectively, to exit through first and second  
13       respective air outlet ducts from the enclosure, wherein cooling inlet air is drawn into the first and  
14       second air duct systems by respective direct drive fan means integrated respectively in the air-cooled  
15      engine and in the generator.

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17               2. The APU of claim 1, wherein the air-cooled engine directly driving the brushless generator  
18       includes a direct coupling such that the output shaft of the air-cooled engine and the generator  
19       armature shaft rotate together.

20

21               3. The APU of claim 1, wherein the air-cooled engine directly driving the brushless generator  
22       includes a direct coupling without the use of a belt, a chain, a clutch or a gear set.

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24               4. The APU of claim 1, wherein the enclosure comprises a frame and a plurality of rigid  
25       panels secured to the frame.

26

27               5. The APU of claim 4, wherein at least a first one of the plurality of rigid panels includes at  
28       least one air inlet opening and at least a second one of the plurality of rigid panels includes at least  
29       one air outlet opening.

1           6. The APU of claim 4, wherein at least a first one of the plurality of rigid panels includes at  
2 least a first opening into a first inlet duct to the air-cooled engine and a second one of the plurality  
3 of rigid panels includes at least a second opening into a second inlet duct to the generator.

5           7. The APU of claim 6, wherein a third one of the plurality of rigid panels includes at least  
6 a first air outlet opening from a first outlet duct from the air-cooled engine.

8           8. The APU of claim 6, wherein a third one of the plurality of rigid panels includes at least  
9 a second air outlet opening from a second outlet duct from the generator.

10          9. The APU of claim 5, wherein at least the first air outlet opening includes a fan for  
11 exhausting air therefrom.

14          10. The APU of claim 1, wherein the air-cooled engine includes a fan integrated with the  
15 output shaft for drawing air into a first air passage proximate heat radiating portions of the engine.

17          11. The APU of claim 10, wherein air drawn into the first air passage and heated therein exits  
18 via the first air outlet duct.

20          12. The APU of claim 1, wherein the air cooled brushless generator includes at least one fan  
21 integrated with the armature shaft for drawing air into a second air passage proximate heat radiating  
22 portions of the generator.

24          13. The APU of claim 12, wherein the air drawn into the second air passage and heated  
25 therein exits via the second air outlet duct.

27          14. The APU of claim 1, wherein the air-cooled engine is a diesel engine.

29          15. The APU of claim 1, wherein the air-cooled engine is a single cylinder engine.

1        16. A high efficiency auxiliary power unit, for a transport vehicle powered by an internal  
2 combustion engine and having a fuel system, an engine exhaust system and a battery powered  
3 electrical system, comprising:

4              an air-cooled engine configured for operation using the fuel supply and the engine exhaust  
5 system of the transport vehicle, and having an integral, forced-air cooling system;

6              an air-cooled, brushless generator directly coupled to an output shaft of the air-cooled engine  
7 and providing simultaneous high voltage AC and low voltage DC outputs without using an inverter  
8 or a converter and having an integral, forced-air cooling system;

9              an enclosure surrounding the air-cooled engine and the air-cooled brushless generator, for  
10 protection and mechanical support; and

11              a system of first and second air ducts within the enclosure to separately convey cooling air  
12 into and through the air-cooled engine and the brushless generator respectively, to exit through first  
13 and second respective air outlets from the enclosure, wherein cooling inlet air is drawn into the first  
14 and second air ducts by respective direct drive fan means integrated respectively in the air-cooled  
15 engine and in the brushless generator.

16  
17        17. The APU of claim 16, wherein the direct coupling of the brushless generator to the  
18 output shaft of the air-cooled engine includes a direct coupling such that the output shaft of the air-  
19 cooled engine and the armature shaft of the generator rotate together.

20  
21        18. The APU of claim 16, wherein the direct coupling of the brushless generator to the  
22 output shaft of the air-cooled engine includes a direct coupling without the use of a belt, a chain, a  
23 clutch or a gear set.

24  
25        19. The APU of claim 16, wherein the air-cooled engine includes a fan integrated into a  
26 flywheel coupled to the output shaft of the air-cooled engine for drawing air into a first air passage  
27 proximate heat radiating portions of the air-cooled engine.

1           20. The APU of claim 19, wherein air drawn into the first air passage and heated therein exits  
2 via the first air outlet of the system of first and second air ducts.

3

4           21. The APU of claim 16, wherein the air-cooled brushless generator includes at least one  
5 fan integrated with the armature shaft for drawing air into a second air passage proximate heat  
6 radiating portions of the generator.

7

8           22. The APU of claim 21, wherein the air drawn into the second air passage and heated  
9 therein exits via the second air outlet of the system of first and second air ducts.

10

11          23. The APU of claim 16, wherein the enclosure comprises a frame and a plurality of rigid  
12 panels secured to the frame.

13

14          24. The APU of claim 23, wherein at least a first one of the plurality of rigid panels includes  
15 at least one air inlet opening into at least one of the first and second air ducts and at least a second  
16 one of the plurality of rigid panels includes at least one air outlet opening from at least one of the first  
17 and second air ducts.

18

19          25. The APU of claim 23, wherein at least a first one of the plurality of rigid panels includes  
20 at least a first opening into a first inlet duct to the air-cooled engine and a second one of the plurality  
21 of rigid panels includes at least a second opening into a second inlet duct to the brushless generator.

22

23          26. The APU of claim 25, wherein a third one of the plurality of rigid panels includes at least  
24 a first air outlet opening from a first outlet duct from the air-cooled engine.

25

26          27. The APU of claim 25, wherein a third one of the plurality of rigid panels includes at least  
27 a second air outlet opening from a second outlet duct from the brushless generator.

1           28. The APU of claim 24, wherein at least the first air outlet opening includes a fan for  
2 exhausting air therefrom.

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4           29. The APU of claim 16, wherein the air-cooled engine is a diesel engine.

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6           30. The APU of claim 16, wherein the air-cooled engine is a single cylinder engine.

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8           31. A system, comprising:

9           a compact, AC operated auxiliary heating and air conditioning unit operable in the cabin of  
10 a transport vehicle powered by an internal combustion engine;

11           an auxiliary power unit (APU) having an air-cooled engine directly coupled to a brushless  
12 generator providing simultaneously a high voltage AC output and a low voltage DC output, operable,  
13 when coupled to a fuel supply, exhaust and electrical system of the transport vehicle, to supply the  
14 AC voltage to the auxiliary heating and air conditioning unit and to at least one AC branch circuit in  
15 the cabin of the transport vehicle, and to supply the DC voltage to the electrical system of the  
16 transport vehicle;

17           control means coupleable with the auxiliary power unit and the auxiliary heating and air  
18 conditioning unit for controlling the distribution of the high voltage AC output and the low voltage  
19 DC output of the auxiliary power unit and controlling the operation of the auxiliary heating and air  
20 conditioning unit and the auxiliary power unit; and

21           harness means for coupling the AC output to the auxiliary heating and air conditioning unit  
22 and the at least one AC branch circuit, the DC output to the electrical system of the transport vehicle,  
23 and the control means to the auxiliary heating and air conditioning unit and to the auxiliary power  
24 unit.

25

26           32. The system of claim 31, wherein the air-cooled engine and the brushless generator each  
27 further include an integral, forced-air cooling system.

1           33. The system of claim 31, wherein the brushless generator provides the simultaneous high  
2 voltage AC output and the low voltage DC output without using an inverter circuit or a converter  
3 circuit.

4

5           34. The system of claim 31, further comprising an enclosure surrounding the air-cooled  
6 engine and the brushless generator, for protection and mechanical support.

7

8           35. The system of claim 34, further comprising a system of first and second air ducts within  
9 the enclosure to separately convey cooling air into and through the air-cooled engine and the  
10 brushless generator respectively.

11

12          36. The system of claim 35, wherein the cooling air exits from the enclosure through first and  
13 second respective air outlets while cooling inlet air is drawn into the first and second air ducts by  
14 respective direct drive fan means integrated respectively in the air-cooled engine and the brushless  
15 generator.

16

17          37. The system of claim 31, wherein the direct coupling of the brushless generator to an  
18 output shaft of the air-cooled engine includes a direct coupling such that an armature shaft of  
19 brushless generator and the output shaft of the air-cooled engine rotate together.

20

21          38. The system of claim 31, wherein the direct coupling of the brushless generator to an  
22 output shaft of the air-cooled engine includes a direct coupling without the use of a belt, a chain, a  
23 clutch or a gear set.

24

25          39. The system of claim 31, wherein the air-cooled engine includes a fan integrated into a  
26 flywheel coupled to an output shaft of the air-cooled engine for drawing air into a first air passage  
27 proximate heat radiating portions of the air-cooled engine.

1           40. The system of claim 39, wherein air drawn into the first air passage and heated therein  
2 exits via a first air outlet of a system of first and second air ducts.

3

4           41. The system of claim 31, wherein the brushless generator includes at least one fan  
5 integrated with an armature shaft of the brushless generator for drawing air into a second air passage  
6 proximate heat radiating portions of the brushless generator.

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8           42. The system of claim 41, wherein the air drawn into the second air passage and heated  
9 therein exits via a second air outlet of a system of first and second air ducts.

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11          43. The system of claim 34, wherein the enclosure comprises a frame and a plurality of rigid  
12 panels secured to the frame.

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14          44. The system of claim 43, wherein at least a first one of the plurality of rigid panels includes  
15 at least one air inlet opening into at least one air duct of a system of first and second air ducts and at  
16 least a second one of the plurality of rigid panels includes at least one air outlet opening from at least  
17 one air duct of the system of first and second air ducts.

18

19          45. The rigid of claim 43, wherein at least a first one of the plurality of rigid panels includes  
20 at least a first opening into a first inlet duct to the air-cooled engine and a second one of the plurality  
21 of rigid panels includes at least a second opening into a second inlet duct to the brushless generator.

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23          46. The system of claim 45, wherein a third one of the plurality of rigid panels includes at  
24 least a first air outlet opening from a first outlet duct from the air-cooled engine.

25

26          47. The system of claim 45, wherein a third one of the plurality of rigid panels includes at  
27 least a second air outlet opening from a second outlet duct from the brushless generator.

1           48. The system of claim 44, wherein the at least one air outlet opening includes a fan for  
2 exhausting air therefrom.

3

4           49. The system of claim 31, wherein the air-cooled engine is a diesel engine.

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6           50. The system of claim 31, wherein the air-cooled engine is a single cylinder engine.

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8           51. The APU of claim 1, wherein the enclosure further comprises a lining of sound absorbing  
9 material.

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11          52. The APU of claim 51, wherein the sound absorbing material comprises a multilayer  
12 configuration of synthetic materials having different densities.

13

14          53. The APU of claim 1, wherein the enclosure is supported on a frame member of the  
15 transport vehicle by a clamping assembly.

16

17          54. The APU of claim 53, wherein the clamping assembly comprises a clamping device for  
18 supporting the enclosure without requiring drilling or welding to complete an installation.

19

20          55. The APA of claim 54, wherein the clamping device comprises U-bolt clamps and  
21 vibration-absorbing isolation pads.

22

23          56. The APU of claim 55, wherein the clamping assembly is adjustable to adapt to different  
24 installations.

25

26          57. The APU of claim 1, wherein the enclosure is supported on a frame member of the  
27 transport vehicle by a plurality of vibration-absorbing devices.

1           58. The APU of claim 57, wherein a vibration-absorbing device comprises a neoprene pad  
2 of predetermined thickness and durometer.

3

4           59. The APU of claim 1, wherein engine exhaust from the air-cooled engine is directly  
5 coupled via an adapter installed in-line with an exhaust pipe of the transport vehicle upstream of the  
6 muffler of the transport vehicle.

7

8           60. The APU of claim 59, wherein the adapter includes an inlet pipe formed of corrugated  
9 tubing to absorb harmonic vibrations traveling in either direction along the inlet pipe.